San Francisco Bay Ecotone
Vegetation Restoration & Management

2009-10 Grant Report

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Abstract

Restoring vegetation adjacent to the tidal marshes of San Francisco Bay at large scales has been an elusive goal. Restoration of one hundred thousand acres of tidal marsh is a regional goal for the estuary, and progress is occurring, but restoring the tidal marsh-upland ecotones and surrounding habitats at such scales was not within our capabilities. These habitats immediately above the intertidal zone are a critical component of the tidal marsh ecosystem, but are dominated by non-native plants that do not provide high quality habitat for native fauna and exclude native flora. Although one-quarter of the estuary's intertidal marshes were not directly impacted by development, many upland habitat types approach extirpation surrounding the estuary. The remaining plant communities are fragmented, their floristic integrity necessarily weakened, which is likely why they now require active propagation to restore.

This report summarizes our fourth year of applied research to describe feasible methods for establishing native-dominated plant communities at large-scales. We have made significant progress towards that goal and this year's testing shows great promise. Seasonal monitoring continues to track performance and additional testing has begun to further refine our methods. For example, we continue to focus on enriching the species palette and improve the adaptability of our seeding mixes across a broader range of site conditions.

Introduction

The restoration of San Francisco Bay's tidal marsh ecosystem is currently a regional priority. The goals set in the Bay Goals Report (1999) are high, but most agree in order to stabilize the ecosystem about 100,000 acres of habitat must be restored. These areas were converted to other uses over the past century, for salt production, farming, and even filled for urban development. Habitats were converted on a grand scale, and by the 1960s perhaps only 25% of the estuary's wetlands had not been modified for our purposes. And habitat conversions occurred at an even greater scale in the surrounding uplands: whether it was in the South and Central Bays where urbanization occurred, or in the North and Suisun Bays where farming was and is prevalent, very little was spared alteration.

The impacts were so extensive that it usually difficult if not impossible to find a suitable reference site to guide restoration planning. The few areas that remain in open space are so small, scattered, or impacted that their vegetation communities are unsuitable for large-scale seed collection. These issues raise concerns about the overall feasibility of restoring ecotonal communities, because the historic species assemblages may be impossible to locate, collect, and properly propagate. In particular restoring symbiotic fungi and soil microbial communities could remain beyond our capabilities.

At the landscape scale it is reasonable to state that historic conditions are vanishingly rare. For example, the South Bay was formerly a mass of seasonal wetlands created by creeks that often did not reach the estuary, which created "sausals" or seasonal willow swamps at their inland deltas. Now the region's creeks are all channelized and less than 1% of historic willow riparian habitat remains. The former seasonal wetlands are now all uplands that are very dry by comparison, so the historic plant communities are no longer appropriate in much of their historic range. This has significant implications for the development of restoration plans, particularly the selection of plant species assemblages.

One type of very common restoration site is levee flanks; the Refuge Complex has over 100 miles of levees they manage at a cost of hundreds of thousands of dollars per year. While they do not necessarily provide high quality habitat, they do create weed dispersal corridors that require management. If native flora can be restored on levees they would reduce the prevalence of weeds. Levees are also often the closest upland sites to the estuary so they would be useful source populations for natural propagation (aka passive restoration) by seed dispersal into restored areas. And there is a potential for vegetation to help minimize management costs by reducing erosion, potentially saving the Refuge a substantial amount of resources. Currently we are planning vegetation restoration at several Refuge sites that are levees for 2011, including the South Bay Salt Pond Restoration Project's Pond A6.

Beyond recreating the historic assemblage of native disturbance-oriented species and propagating them across large tracts of land, a significant portion of this project is outreach, education, and regional involvement. We continued our work with vegetation managers throughout the estuary, and held our second meeting focused on genetic conservation issues. And we became involved in the newly-formed Central Coast Native Plant Nursery group to improve our Phase II (container planting) development. Beyond working with appropriate professional groups we also began reaching out to local government and the public at large. Because the Refuge is surrounded by cities and residential areas, weeds can easily arrive by car, water, visitors, or wind. Therefore, reducing weeds in urban areas surrounding the Refuge will help protect its plant communities. Our tidal marsh-upland ecotonal restoration research provides the opportunity for educating the public on the importance of these habitats to the tidal marsh ecosystem as well as conscientious choices for home gardening.

Methods & Materials

The descriptions below build-upon last year's report (2008-2009), just as our methods are a progression from last year. If you have not reviewed that report you may have difficulty following this one, so last year's report was included with this submittal for your convenience (without photo-appendix to reduce its size). The following sections describe our pre-seeding weed abatement (salinization), seed sowing (broadcast and hydroseeding), as well as our root division propagation (hydrosprigging) testing for the 2009-10 growing year.

Salinization

This past year we performed salinization on several appropriate areas of the Alviso site. Saline irrigation amounts and seasonal timings were similar to previous years. As in previous years we used a portable "trash pump" to draw salt water from New Chicago Marsh into an irrigation system that covered about ¼-acre per set. This spray irrigation array was run for approximately 9 hours and was pumping 40-50 parts per thousand salinity onto the aerial parts of the plants and soil. Approximately 2 acres of the site were salinated; other portions of the site are not considered halophytic habitats so they have not been treated.

November Hydroseeding

In November we hydroseeded 6 acres of uplands adjacent to salt marsh in Alviso at the Environmental Education Center. Table 1 contains a list of the species that were available from our list of species for testing. This round of testing focused on native forb species (aka broadleaf plants) and included the following:

A) 13 native forb species seeded
B) 2 grass species propagated by root divisions (Hydrosprigging)
C) 3 other grass species seeded (that recruited from seed in 2008)

Table 1. November Species Palettes

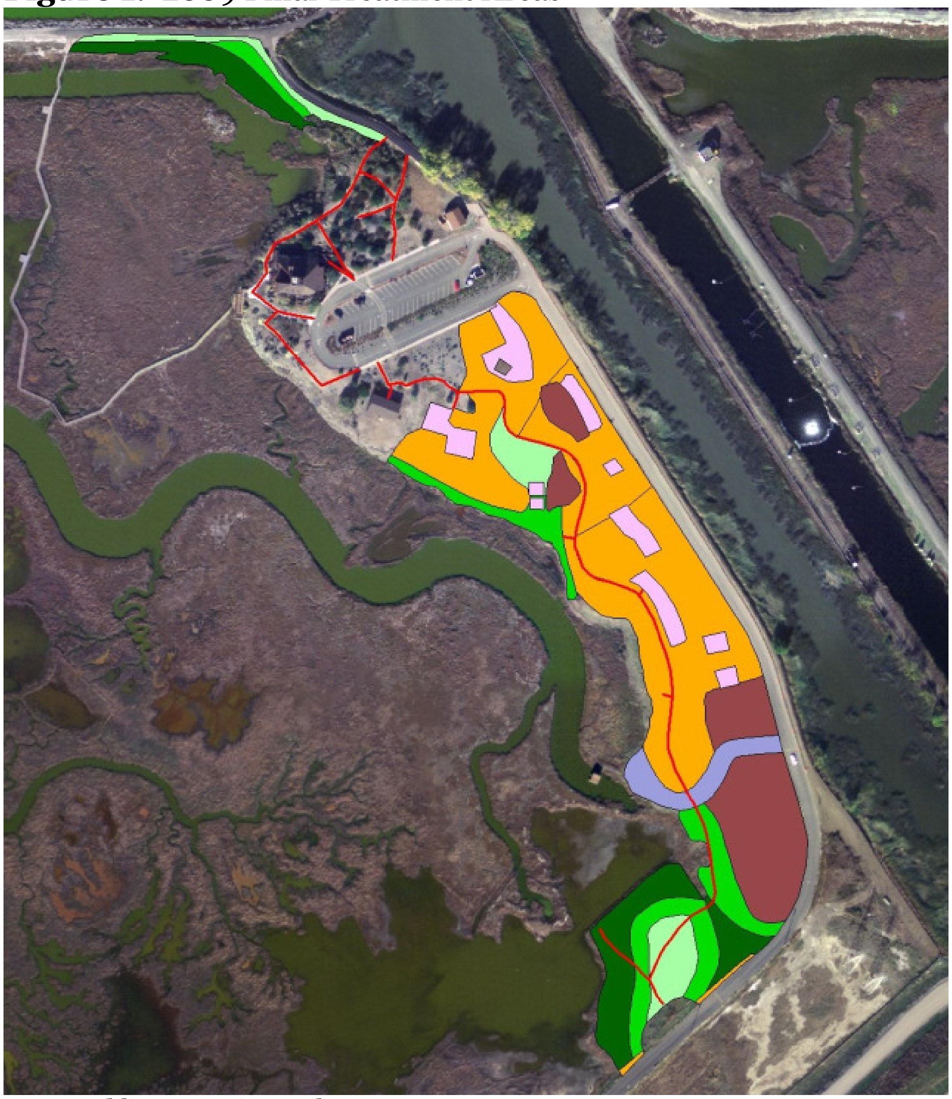
Species	Name	Guild	Propagule	Performance
Ambrosia psilostachys	western ragweed	forb	seed	some
Amsinckia menziesii	common fiddleneck	forb	seed	**poor**
Artemesia douglasiana	mugwort	forb	seed	little
Aster chilensis	Pacific aster	forb	seed	some
Atriplex triangularis	spearscale	forb	seed	some
Baccharis douglasii	marsh baccharis	forb	seed	absent
Bromus carinatus	California brome	grass	seed	absent
Centromadia pungens	common spikeweed	forb	seed	**good**
Distichlis spicata	saltgrass	grass	**root**	absent
Euthamia occidentalis	seaside goldenrod	forb	seed	little
Frankenia salina	alkali heath	forb	seed	little
Grindelia stricta	marsh gumplant	forb	seed	little
Heliotropium curassavicum	seaside heliotrope	forb	seed	absent
Leymus triticoides	creeping wildrye	grass	**root**	absent
Lotus scoparius	deerweed	forb	seed	little
Trifolium wildenovii	tomcat clover	forb	seed	absent
Vulpia microstachys	three-week fescue	grass	seed	good
Nasella pulchra	purple needlegrass	grass	seed	absent

Note: performance is presented here to avoid redundant tables.

The species were organized into 5 separate seed mixes according to their salt tolerance and our habitat goals. These mixes were applied as shown in Figure 1 below:

1) Forbland (orange)
2) Woodland (brown)
3) Saltgrass sprigging and seeded associates (dark green)
4) Creeping wildrye sprigging and seeded associates (light green)
5) Mixed sprigging and seeded associates (bright green)
6) Grassland testing areas from previous years (pink)

Figure 1. 2009 Final Treatment Areas



Note: red lines are site trails.

The work was contracted to a commercial hydroseeding company. The general method for the work was a two-pass approach, with the hydroseed slurry consisting of: compost, hydromulch, fertilizer, and grass seed or sprigs (i.e. root divisions) in the first layer; and hydromulch and forb seed in the second layer. The idea behind the two-pass method was to better bed and mulch the grass sprigs (as well as grass seed), while leaving the forb seed closer to the surface, which should improve success in both guilds. However, the primary motivation for the two-pass method, which more than doubles the implementation effort, was hydrosprigging because in a one-pass approach some root divisions would have ended up on or near the surface and failed. Pre-seeding weed abatement included salinization in portions of the site as well as weeding by our volunteer groups for over a decade.

Berm and Banks Broadcast Seeding

Based on observations of the performance of the November hydroseeding, and due to additional funding we were able to perform an additional acre of broadcast seeding to test more refinements to our methods. This included newly identified species that were commercially available (see Table 2 below), and modifications to the materials utilized to bed and mulch the seed. We also added many species that should perform well adjacent to fresh marshes (adjacent marsh is tules).

It was also an opportunity to test the feasibility and success of hand broadcast seeding for small sites, because sites which are too small for commercial operations will be common. The basic method utilized was to spread about one inch of compost, to create a better seed bed on severely compacted soils, broadcast the seed mixes shown below in Table 2, with the "Wet" mix sown closer to the marshes and the "Dry" mix above, and hand spread rice straw to mulch. Due to significant wind exposure we tested securing a portion of the straw with some straw blankets we had left over from the banks areas. Pre-seeding weed abatement was performed on the berm area but not the banks. These areas are along the east (berm) and northern (banks) edges of the main seeding area shown in Figure 1 above, but they are long, linear features that do not display well at that (or any reasonable) scale.

Table 2. Berm Species Palettes

Mix	Species	Name	Guild	Performance
Wet	Agrostis exarata	spike bentrgrass	grass	*unknown*
Wet	Artemisia douglasiana	mugwort	forb	poor
Wet	Atriplex triangularis	spearscale	forb	little
Wet	Baccharis douglasii	marsh baccharis	shrub	poor
Wet	Bromus carinatus ssp. maritimus	seaside brome	grass	*unknown*
Wet	Carex praegracilis	field sedge	sedge	*unknown*
Wet	Elymus glaucus	blue wildrye	grass	*unknown*
Wet	Eschscholzia californica var. maritima	California poppy	forb	**good**
Wet	Festuca rubra	red fescue	grass	*unknown*
Wet	Hordeum brachyantherum	meadow barley	grass	*unknown*
Wet	Hordeum depressum	alkali barley	grass	*unknown*
Wet	Lupinus succulentus	arroyo lupine	forb	**good**
Wet	Vulpia microstachys	three-week fescue	grass	**good**
Dry	Achillea millefolium	yarrow	forb	**good**
Dry	Amsinckia menziesii	common fiddleneck	forb	**good**
Dry	Artemisia californica	California sagebrush	shrub	little
Dry	Artemisia douglasiana	mugwort	forb	little
Dry	Aster chilensis	purple aster	shrub	absent
Dry	Bromus carinatus ssp. maritimus	seaside brome	grass	*unknown*
Dry	Centromadia pungens	common spikeweed	forb	**good**
Dry	Eriogonum nudum	buckwheat	shrub	poor
Dry	Eriophyllum confertiflorum	golden yarrow	forb	little
Dry	Eriophyllum lanatum	wooly sunflower	forb	poor
Dry	Eschscholzia californica var. maritima	California poppy	forb	**good**
Dry	Euthamia occidentalis	western goldenrod	forb	little
Dry	Festuca idahoensis	Idaho fescue	grass	*unknown*
Dry	Heliotropium curassavicum	seaside heliotrope	forb	poor
Dry	Hordeum depressum	alkali barley	grass	*unknown*

Dry	Koeleria macrantha	prairie june grass	grass	*unknown*
Dry	Lotus purshianus	Spanish clover	forb	**good**
Dry	Lotus scoparius	deerweed	forb	poor
Dry	Lupinus succulentus	arroyo lupine	forb	**good**
Dry	Mimulus aurantiacus	sticky monkeyflower	subshrub	poor
Dry	Nassella pulchra	purple needlegrass	grass	*unknown*
Dry	Suaeda moquinii	inkweed	forb	little
Dry	Trifolium willdenovii	tomcat clover	forb	poor
Dry	Vulpia microstachys	three-week fescue	grass	**good**

Note: "unknown" indicates they were not found but many grasses did not reach the flowering stage so they remained unidentifiable.

Results

Salinization

Initial results were excellent, and saline irrigation easily eliminated our site's non-halophytic weeds across two acres. Then we noticed that many of those weeds re-emerged from seed later in the year, which surprised us given previous results. However, salinization amounts did not seem to interfere with the success of our seeding mixes in many areas, and likely interfered with many weed's phenological advantage by giving the seed mixes a head start.

Hydroseeding

Observations of the initial performance of these methods and materials over the rainy season were significant, and were part of the reasoning behind performing the berm and banks seeding later in the rainy season. Our observations are presented below in chronological order, but one key overall observation was of the spatial variability of success; some areas did very poorly while others did exceedingly well, and sometimes these areas were immediately adjacent to each other. Figure 2 is a selection of photopoints from mid-summer. This variability could be attributable to propagule issues (i.e. seeds and mixes), hydroseeding methods (and in particular the tank mixing methods), hydromulch performance, bird browse, or patchy soil conditions.

Our primary observation was that the hydromulch (Hydrostraw) did not persist long enough on the site to provide adequate coverage for our seed mixes. It only lasted 1-2 months, which is the product's specification so it performed as advertised. However, we have species that germinate later so our future hydromulch specification will include a product that persists for approximately 1 year to better ensure the entire seed mix remains mulched. We also noted that flocks of passerines (small birds) were browsing the mulched areas. We were unable to see if they were successfully browsing the seed, but they remain a potential factor in the patchy success of the hydroseeding.

A big surprise was fiddleneck (*Amsinckia menziesii*) not germinating much at all. It is possible that the late seeding (November instead of October) played a role, although the germination cueing for fiddleneck is not known. Its phenology leads us to believe it could be heat and moisture because it emerges quickly from seed. Regardless of the reason vegetation managers have said it does not always germinate so it is best to not rely on it alone for cover, which is why we have continued to search for and add other species of native wet-season forbs, such as those used in the "berm and banks" seeding below.

Figure 2. Mixed Results (2009-2010)

a. Excellent

b. Mixed

b. Mixed

c. Poor

Hydrosprigging

Hydrosprigging appears to have been a failure. We have not observed any saltgrass (*Distichlis spicata*) or creeping wildrye (*Leymus triticoides*) in areas that were hydrosprigged. The control plots that were hand sprigged showed good success, so rainfall and supplemental irrigation were adequate. The cause of the failure could have been poor rootstock or the hydromulch may not have been adequate to mulch the sprigs, but the results in all hydrosprigging treatments were not acceptable.

Broadcast Seeding

Hand broadcast seeding, over compost top-dressing and covered by straw mulch, was successful on the berm area, but not successful on the banks areas. The berm was pre-treated for weeds, but the banks were not, and the banks were seeded last (end of February, beginning of March). Because these areas were seeded so late in the season (February-March) we provided them with a “false spring” by irrigating once per week as needed through June. The only other significant difference between the berm and banks was the banks only had straw blankets covering the seed, which were quite thin, and may not have adequately mulched the seed. Some areas of the berm also included the thin straw blankets to help hold the straw down due to heavy wind exposure, which may have been excessively thick or impeded germination somewhat because recruitment was lower in those areas.

Conclusions

At large scales "direct competition" is likely the only feasible tactic for reducing the abundance of undesirable plants. Part of our rationale are the costs associated with large-scale herbicide applications (both project resources and non-target biotic effects); however an even greater reason is the utter futility of controlling weeds when no native flora are present to replace them. Without a native seedbank, or adequately-sized stands of native communities nearby, the only possible outcomes are reinvasion of non-native species or recruitment from the weed seedbank, both of which are unacceptable given the apparent waste of resources utilized in the control program.

There are cases where this does not apply, such as when there are no native competitors (i.e. *Spartina alterniflora* invasion of mudflats) and/or the non-native species is a superior competitor (i.e. highly invasive like *Lepidium latifolium*) and should be controlled regardless of subsequent vegetative trends. But in habitats adjacent to San Francisco Bay many non-native species are not highly invasive and likely only abundant due to the paucity of the native flora. Therefore, it is advisable to create a programmatic requirement to actively manage native revegetation as a component of non-native control if the seedbank or adjacent vegetation is inadequate to ensure an acceptable outcome. This should reduce the mid to long-term weed management costs by reducing the abundance of weeds, which could eventually pay for increased costs in the short to mid-terms from adding a reseeding component to vegetation management.

Of course reseeding natives across large-acreages is only appropriate if a viable method exist, including a diverse array of native species available in commercial seed quantities. We have been working on this and can safely report that we are at least three-quarters of the way to describing methods feasible for large sites, and continue working with native seed suppliers to get many of these species into commercial production. Approximately half of our working list of species (see Table 3 below in the 2010-11 Implementation Plan), that either have worked well in seeding or we anticipate will work are commercially available, and at least ten of those contributed significantly to plant cover last year. We are currently monitoring the site for second year performance because it is critical to understand how these species re-seed themselves and compete in subsequent generations.

Hydroseeding

While this year's hydroseeding trials were not without problems we have found the method functional and believe it will be a good method for sowing seed across large sites. Our results varied: some areas were almost devoid of vegetation, others were either dominated by non-natives or seeded natives, and some led us to question the seeding rates of some species due to what could be considered excessive success. The sheer dominance of common spikeweed (*Centromadia pungens*) in some areas led a few weed volunteers to question its use in general.

The variability of results was very patchy, some of which were immediately adjacent to each other. This led us to question the effectiveness of the hydroseeding contractor's methods. The contractor believed their custom hydroseeder could adequately mix the slurry regardless of the sequence of adding ingredients or the slurry's thickness (i.e. compost proportion). But our observation of the patchiness of results, combined with our discussions with other hydroseeding professionals (Finn Corporation's west coast representative, who works in a different state), lead us to believe they could be incorrect. So we will be specifying tank-mixing procedures in any subsequent hydroseeding work and adding it to the specifications package we are producing. The possibility remains that soil conditions could be a factor in the results, either structural (i.e. compaction), chemical (i.e. nutrition), or biological (i.e. soil ecology), so we are currently performing some specific tests to investigate this further. And of course both possibilities could be involved, along with bird browse and other possible sources of variability.

It was quickly apparent that the hydromulch used was inadequate for our purposes. Although it appeared to form a good barrier that could retain moisture and hold on slopes, it did not persist longer than a month or two, and our seed mixes germinate over a much broader period so the possibility remains that some of the seed was not mulched adequately. There are hydromulches that persist longer, such as Hydrostraw's BFM product as well as some products made by Flexterra, however blown straw can also perform adequately. Future implementations will take advantage of opportunities to compare mulches and investigate this further.

Hydrosprigging

Hydrosprigging will not be pursued as a method of propagating species mechanically. Besides the failure of this year's treatments to produce any results, modifying our methods to improve sprigging performance likely causes significant problems for hydroseeding. The primary problem is timing; sprigs must be kept moist for about a month so they can root; therefore, the application timing was "cheated" into the rainy season to ensure adequate rainfall. This allows any significant earlier rainfall to give the weeds a head start. And this may also reduce germination of some species, because as temperatures fall germination cues can be missed for some species.

Another problem with sprigging is the need to adequately bed root divisions. This requires compost be added to the hydro-slurry, which decreases the coverage per tank. The tank coverage was cut in half for the specifications we used, doubling the implementation effort and associated costs. We went even further, quadrupling the effort and costs by using a two-pass method to try and give the sprigs even better bedding and mulching, but our efforts were not rewarded and we did not find either sprigged species in the treatment areas.

Our final issue with hydrosprigging is the requirement that soil fertility be good so the divisions can more easily root. We added fertilizer to the tanks in order to improve soil fertility, which is generally poor on our site. This did not appear to help the sprigs become established and likely contributed to the exceptional growth of many weed species that are adapted to capitalize on free nitrogen and other nutrients. All of this coupled with the fact that the species we sprigged are commercially available in seed stock of acceptable provenance leads us to drop this method from further investigation.

Broadcast Seeding

Although our hand-broadcast methods are only suitable for smaller sites there are mechanical methods for broadcasting seed across larger areas, including dry materials blowers (usually used for spreading bark but compost could also be spread) that have seed injectors for metering seed into the "stream", may still be tested in the future. The berm area performed much better than the banks, where pre-seeding weed abatement may have played a significant role in the relative success of the two areas. Overall the berm may have been one of the most balanced performers of any seeded area during this round of testing. The only reservation we have was the seeding rate may have been too low.

We should point out that these areas have always had poor plant communities, so we attempted to at least give the seed better bedding by top-dressing these areas with one inch of compost. Modifications to the methods used in November also included utilizing straw instead of finer mulches, which has persisted well to the present. The only issue we have had with straw mulch is keeping it in place with exposure to heavy winds, a common element of sites adjacent to the estuary. One additional modification was improving the diversity of the species palette, particularly the winter/spring (wet season) community because fiddleneck (*Amsinckia menzieseii*) was the only significant wet-season competitor seeded in November. New additions California poppies (*Escholschzia californica*), arroyo lupine (*Lupinus succulentus*), Spanish clover (*Lotus purshianus*), inkweed (*Suaeda moquinii*), and California sagebrush (*Artemisia californica*) all performed very well.

Salinization
We believe that due to greater rainfall amounts this year the treatments did not appear to persist as in previous drought years (2006-2009). This is likely due to a leaching of salts out of the upper soil horizons. So we are adding a qualifying remark to the persistence of our salinization treatments: cumulative rainfall amounts will dictate the longevity of saline irrigation's effectiveness on controlling non-halophytic plants. Salinization remains a highly effective and feasible treatment of many ecotonal weeds, particularly since it can be used to address phenological issues in the competition between weeds and desirable species: eliminating the early weed seed germination can "release" desirable species from the seedbank or seed mix.

This new qualifier may not apply to granular salt additions because cumulative rainfall amounts dictate how much salinity is leached from the salt crystals into the soil-water matrix. Perhaps this method could be adapted to varying rainfall amounts, which is an excellent benefit in addition to the ease of treatment compared with pumping salt water onto a site. Carla Fresquez, a graduate student performing her research at Elkhorn Slough NEER is working on quantifying the amount of granular salt addition needed to control common weeds in tidal marsh-upland ecotones as part of her dissertation. She has already generated some results with this method and has some preliminary results to share that could guide others trying the technique.

Tidal Marsh-Upland Ecotone Vegetation Managers
We were able to organize another meeting in October of this new group. The first meeting in September 2009 was an introduction and general overview, a scoping meeting to summarize known issues and get a feel for the group. The second meeting focused on genetic conservation issues related to restoring plant communities. The meeting was led by Dr. Deborah Rogers, a genetic conservationist with 30-years of experience on these issues in the restoration and management of natural communities with USFS, UC Davis, and now with a group that manages private reserves.

The meeting introduced the concept of genetic conservation to the group, explaining the issue in practical terms that relate to our every-day work, and we discussed some case studies that typified the problems associated with poor genetic conservation in restoration work. We then had the opportunity to discuss the issues we face in our work in the region and how we might apply good genetic conservation principles to improve the success of our projects. The end-products of the meeting were that we need to draft species abstracts for the communities we work in so we can apply specific genetic conservation principles to them. This work is ongoing.

2010-11 Implementation Plan
Our primary goal for this round of testing at the EEC in Alviso is to monitor the seeding reported here. We need to know how this seeding work performs in its second year (and beyond) to see if the effects are lasting. Do these species re-seed themselves well and compete against weeds in the years following implementation? A secondary goal is to do some tests in areas that did not perform well. It should be possible to test some of our issues (stated above) with the hydroseeding work by seeding into those areas. If the same species that were hydroseeded last year germinate this year then we should be able to eliminate some of the potential reasons, or perhaps justify specific testing such as soil analyses.

Our methods will also be a test, as we want to know if "rough seeding" works with our species. Can we simply broadcast seed into thatch or bare areas, and mulch as needed, without any seedbed preparation, and get acceptable results? So this year we have already seeded three acres by hand, using volunteers to broadcast some of the species in Table 3 below, straw mulch the areas, and then stomp around to help ensure the seed falls to the ground. We also hand broadcast specific species in specific areas to test their performance from seed.

Table 3. Working List of Species for Phase I Revegetation (Seeding)

Rank	Guild	Species	Code	Common Name	Source & Provenance	Note
1	**forb**	**Achillea millefolium**	**ACMI**	**common yarrow**	**PCS stock, Santa Clara Co**	
1	**forb**	**Amsinckia menziesii**	**AMME**	**fiddleneck**	**PCS production, EEC recruit**	**germination cueing?**
1	**forb**	**Calandrinia ciliata**	**CACI**	**red maids**	**PCS stock, Alameda Co**	**2011 addition**
1	**forb**	**Centromadia pungens**	**CEPU**	**common spikeweed**	**PCS production, EEC recruit**	
1	forb	Conyza canadensis	COCA	Canadian horseweed	EEC recruit	collect
1	forb	Conyza coulteri	COCO	Coulter's horseweed	in search of...	better than C. canadensis?
1	forb	Epilobium brachycarpum	EPBR	annual willow herb	EEC recruit	collecting at EEC
1	**forb**	**Escholschzia californica**	**ESCA**	**California poppy**	**PCS stock, Monterrey Co.**	**local source?**
1	forb	Iva axillaris	IVAX	poverty weed	Coyote Hills?	searching
1	**forb**	**Lupinus succulentus**	**LUSU**	**arroyo lupine**	**PCS stock, Schaaf Farms**	**local source?**
1	forb	Malvella leprosa	MALE	alkali mallow	Disk Drive or Warm Springs	NRCS PMC test? (EEC testing too)
2	**forb**	**Ambrosia psilostachya**	**AMPS**	**western ragweed**	**PCS stock, Santa Clara Co**	**allergy concerns?**
2	**shrub**	**Artemisia californica**	**ARCA**	**California sagebrush**	**PCS stock, Monterrey Co.**	**local source?**
2	**forb**	**Aster chilensis**	**ASCH**	**Pacific aster**	**PCS stock, Santa Clara Co**	**A. subulatus a better choice?**
2	**forb**	**Atriplex triangularis**	**ATTR**	**spearscale**	**PCS stock, Alameda Co**	
2	**forb**	**Cressa truxillensis**	**CRTR**	**alkali weed**	**PCS stock, Alameda Co**	**2011 addition**
2	forb	Epilobium ciliatum	EPCI	perennial willow herb	EEC recruit	collect at EEC in 2011
2	**forb**	**Euthamia occidentalis**	**EUOC**	**Western goldenrod**	**PCS stock, Santa Clara Co**	
2	**forb**	**Frankenia salina**	**FRSA**	**alkali heath**	**PCS stock, DE SFB NWR**	
2	**shrub**	**Grindelia stricta**	**GRST**	**marsh gumplant**	**PCS stock, DE SFB NWR**	**NRCS PMC test?**
2	**forb**	**Heliotropium currasavicum**	**HECU**	**seaside heliotrope**	**PCS production, EEC recruit?**	**NRCS PMC test?**
2	forb	Hemizonia congesta	HECO	hayfield tarweed	Foothills Park	collect
2	forb	Limonium californicum	LICA	California sealavender	Inner Bair Island	collect
2	**forb**	**Lotus purshianus**	**LOPU**	**Spanish clover**	**PCS stock, Yolo Co**	**local source?**
2	forb	Madia sativa	MASA	coast tarweed	UC BORR/MIDPEN	collected (more sources needed)
2	forb	Rumex maritimus	RUMA	golden dock	old Alameda Creek channel	in search of...
2	**forb**	**Suaeda moquinii**	**SUMO**	**inkweed**	**PCS stock, San Joaquin Co**	**collect from Warm**

						Springs
2	shrub	Toxicodendron diversilobium	TODI	poison oak	in search of…	human contact issues
2	forb	Trifolium wormskioldii	TRWO	cows clover	in search of…	
2	**grass**	**Vulpia microstachys**	**VUMA**	**annual fescue**	**PCS stock, Santa Clara Co**	
3	**forb**	**Artemisia douglasiana**	**ARDO**	**mugwort**	**PCS stock, Santa Clara Co**	
3	**forb**	**Baccharis douglasii**	**BADO**	**marsh baccharis**	**PCS stock, Alameda Co**	
3	**sedge**	**Carex praegracilis**	**CAPR**	**field sedge**	**Hedgerow stock, Yolo Co**	**EEC testing**
3	grass	Deschampsia cespitosa	DECE	tufted hairgrass	Bird Island?	in search of…
3	**shrub**	**Eriogonum fasciculatum**	**ERFA**	**California Buckwheat**	**PCS stock, Alameda Co**	**EEC testing**
3	**forb**	**Eriophyllum confertiflorum**	**ERCO**	**golden yarrow**	**PCS stock, Santa Clara Co**	
3	grass	Festuca rubra	FERU	red fescue	Tomales Bay halophytic populations	Richmond collections available
3	**grass**	**Hordeum depressum**	**HODE**	**alkali brome**	**PCS stock, Contra Costa Co**	**Warm Springs?**
3	**grass**	**Leymus condensatus**	**LECO**	**giant wildrye**	**PCS stock, Monterrey Co.**	**NRCS PMC testing**
3	grass	Leymus x multiflorus	LEMU	many-flowered wildrye	BORR, Mare Island, or NRCS?	NRCS PMC test?
3	**grass**	**Leymus triticoides**	**LETR**	**creeping wildrye**	**Hedgerow stock, Contra Costa Co**	**NRCS PMC test?**
3	forb	Suaeda calceoliformis	SUCA	horned seablight	in search of…	
4	grass	Agrostis pallens	AGPA	Diego bent grass	in search of…	
4	forb	Eriophyllum lanatum	ERLA	wooly sunflower	PCS stock, Sierra Foothills	local source needed
4	sedge	Juncus sp.	JUsp	salt marsh rushes	in search of…	appropriate species?
4	forb	Lomatium utriculatum	LOUT	hog fennel	in search of…	
4	forb	Phacelia distans	PHDI	common phacelia	in search of…	
4	grass	Puccinellia nutkaensis	PUNU	alkali grass	Greco Island & SW Bay marshes	

Notes: Ranks are the importance in Phase I (seeding) revegetation, either as tested or assumed. Bold text indicates species we either have tested, are currently testing, or will test in 2011. Plain text indicates species we are or hope to acquire and test in the near future, and this list is continually updated as our understanding of early seral, disturbance oriented native communities continues to improve.

We are also beginning work on applying our methods to other sites. This will allow us to test our methods on sites that have not been subject to active vegetation management for years, and also sites where conditions likely vary from those found at the EEC. These are important because any one site, and in particular our site in Alviso that has been subject to active management for over a decade, will be significantly different from other sites where these methods could be utilized. So it is essential that these methods be applied across sites throughout the region that represent the range of conditions to better ensure their effectiveness.

Currently we are planning work at two additional sites: La Rivere Marsh in Newark, CA and Pond A6 in northern Santa Clara County. La Riviere Marsh is perhaps one of the best tidal marsh restoration sites in the estuary, albeit a muted-tidal system, but it continues to be impaired by poor ecotonal vegetation communities. Over the next year we will be performing a variety of weed abatement procedures to address the concerns of FWS site managers and seeding the site in the Fall of 2011. We will likely utilize a variety of methods due to access issues at this site.

Pond A6 is a former salt evaporation pond and now part of the Don Edwards San Francisco Bay NWR. It is also part of the South Bay Salt Ponds Restoration Project, a 15,100 acre area planned for restoration and management by a cooperative Federal-State organization. The construction planning and implementation are being managed by Ducks Unlimited, with funding from the North American Wetlands Conservation Act (NAWCA) Standard Grant program. We are planning the ecotonal vegetation management, with funding from a Santa Clara Valley Water District (SCVWD) Environmental Enhancement grant.

Our contributions to date have included performing soil testing to investigate a lack of any vegetation in some upland areas, and reviewing the elevation specifications related to ecotonal habitats. The results of soil sample testing indicated an excessive amount of marine salts in the upper foot of the soil profile, and we were able to have the project include soil scraping to the scope of construction work in areas where the levees were not being lowered. This has the added benefit of constituting pre-seeding weed abatement as the entire crop of weeds and their seedbank have been removed across the 13 acres we plan on seeding next fall. Construction has also included lowering some levees to “the elevation of the marshes outside the pond” (Ducks Unlimited). Our review found that their target elevation would likely take these areas down lower than necessary, which would likely eliminate their utility as ecotonal habitats for species of special concern (ESA-listed). So now the construction will leave lowered areas higher.

Our current work for both sites includes continuing to improve our working list of species (Table 3 above), identify source populations in the region, acquire collection permissions, collect for testing on our sites and if appropriate get them into commercial production, in addition we continue to work on the specific implementation methods that will be utilized, which will include aerial hydroseeding.

Literature Cited

Goals Project. 1999. Baylands Ecosystem Habitat Goals. A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystem Goals Project. U.S. Environmental Protection Agency, San Francisco, Calif./S.F. Bay Regional Water Quality Control Board, Oakland, Calif.

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Hands On Bay Area – volunteer coordination group
One Brick – volunteer coordination group
Mayne School – volunteer groups
St. Andrews School – volunteer groups
and many Community Service Days

Photo of “the berm” (D. Thomson)